



# **MS3.2: Workshop drivers of annual to decadal changes in climate**

Milestones

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# 1 Executive summary

On Monday 22 September (14.00 – 17.05 CET) and Tuesday 23 September (14.00 – 16.30 CET), the EXPECT consortium hosted an online workshop on drivers of annual to decadal changes in climate. The primary objective of this two-day workshop was to highlight results for Work Package 3 (WP3; Drivers of annual to decadal changes in climate). This included results both from EXPECT partners and those involved with the WCRP Lighthouse on Explaining and Predicting Earth System Change and the APARC LEADER activity. This provided an opportunity to increase general awareness, receive feedback and suggestions, and establish potential collaboration opportunities.

# 2 Workshop program

Monday 22 <sup>nd</sup> September	
1400-1405	Introduction (Doug Smith)
1405-1435	Can we better trace European heat extremes back to atmospheric circulation patterns? (Julianna Oliveira, Leipzig Uni)
1435-1505	Explaining and predicting the Southern Hemisphere eddy-driven jet (Julia Mindlin, Leipzig Uni)
1505-1535	Emerging hot spots of agricultural drought (Emily Black, Reading Uni)
1535-1550	Break
1550-1620	Counterfactual seasonal hindcasts: concept and their use in understanding recent climate trends (Michael Mayer & Jacob Maddison, ECMWF)
1620-1650	Contribution of forcing factors and internal variability to the increase in European summer temperatures over the last decades (Pedro Roldan, BSC)
1650-1705	Discussion (if needed)

Tuesday 23 <sup>rd</sup> September	
1400-1430	Drivers of multi-decadal trends in northern hemisphere summer atmospheric circulation (Gerard Marquet, BSC)
1430-1500	Drivers of multi-decadal trends in atmospheric circulation in the Pacific (Melissa Seabrook, Met Office)
1500-1515	Break
1515-1514	Dynamical systems methods to understand projected heatwave intensification (Eylon Vakrat, Toronto Uni)

1545-1615	The need to account for model error for prediction, projection and attribution (Doug Smith, Met Office)
1615-1630	Discussion (if needed)

### 3 Attendees

The workshop brought together **46 participants** from various consortium institutions. For data-protection purposes and in line with GDPR requirements, all personal details have been omitted from this report.

### 4 Next steps

Some of the results shown in this workshop will begin to be used to develop integrated attribution and prediction in the next step of EXPECT (WP4). This will involve (1) attributing atmospheric circulation signals seen in decadal predictions to individual forcings and internal variability, (2) identifying the key processes, (3) assessing how well climate models represent those processes, and (4) calibrating the predictions if necessary.

### 5 Conclusions and outcomes

Several talks highlighted model errors and differences. For example, northern hemisphere summer atmospheric circulation trends appear to be influenced by anthropogenic aerosols since there is a high pattern correlation between the model simulations and the observations, but the model pattern is too weak. This is potentially consistent with the signal to noise paradox, but more work is needed to identify the cause and potentially calibrate the models. Furthermore, it was shown that different models can have opposite responses to the same forcings. If models have different responses, then we should no longer use the multi-model ensemble mean since the true response could be like any of the models, and if there are signal to noise errors then the true response might not be captured by any of the models. The very important key point is that the climate science community needs to put much more emphasis on taking model errors seriously by identifying the true forced response and testing for signal to noise errors.

Part of this future work will be done in collaboration with the WCRP Lighthouse on Explaining and Predicting Earth System Change, and the APARC Leader activity, both of whom attended the workshop.